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Ecology, People & Environment

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Seeing the forest for the trees: tree responses to drought and heat

Globally, climate change-type drought and forest disturbance is garnering increasing concern. Southwest Western Australia provides an ideal model for studying climate change effects on forest ecosystems, as this region:

- has undergone a distinct shift in climate since the mid-1970s;
- has experienced an increasing frequency of severe drought and heat events;
- is a biodiversity hotspot; and
- contains a forest which has a distribution over 1 million hectares across aridity and temperature gradients (the Northern Jarrah forest).

Beginning in February 2011, after one of the driest years since comparable records began and following nine days over 35°C, tree crowns in the Northern Jarrah Forest began to rapidly discolor and die. This process continued through May 2011, resulting in discrete patches of nearly complete forest canopy loss (Figure 1). An estimated 16,500 ha of the Northern Jarrah Forest was severely affected (Matusick *et al*. 2013; Brouwers et al. 2013).

We compared the early response of the two main forest species (jarrah *Eucalyptus marginata* and marri *Corymbia calophylla*) following this sudden and severe drought and heat event.

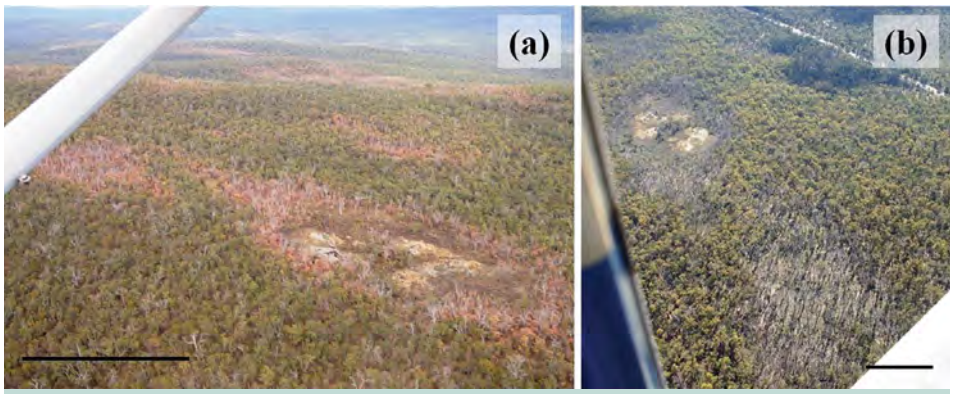

FIGURE 1 Aerial photo of an area of the Northern Jarrah Forest, Western Australia (Site 74), at (a) three and (b) 16 months following drought. Scale bar represents approximately 200 metres

Methods and results

Twenty forest patches affected by the drought were selected randomly from a population of 235 affected patches identified during an aerial survey conducted at the end of the drought period (May 2011).

Sites were visited at three (June/July 2011) and 16 months (July 2012) following the drought event. The health of all jarrah and marri (≥1 cm diameter at breast height; DBH) were categorized into one of three crown health categories at three months: (1) unaffected crowns; (2) moderately affected crowns which had predominately dry and discoloured leaves, but still retained green foliage; and (3) severely affected crowns that showed complete crown dieback.

Since the primary survival mechanism in drought-affected trees was resprouting from the tree or below-ground tissue, the presence or absence of resprouts was determined at 16 months.

Jarrah was more susceptible to partial and complete crown dieback compared to marri, three months after the drought (Figure 2). However, at 16 months, resprouting among trees exhibiting complete crown dieback was similar between species.

Overall, Jarrah trees were more likely to die from the impacts of drought at 16 months.

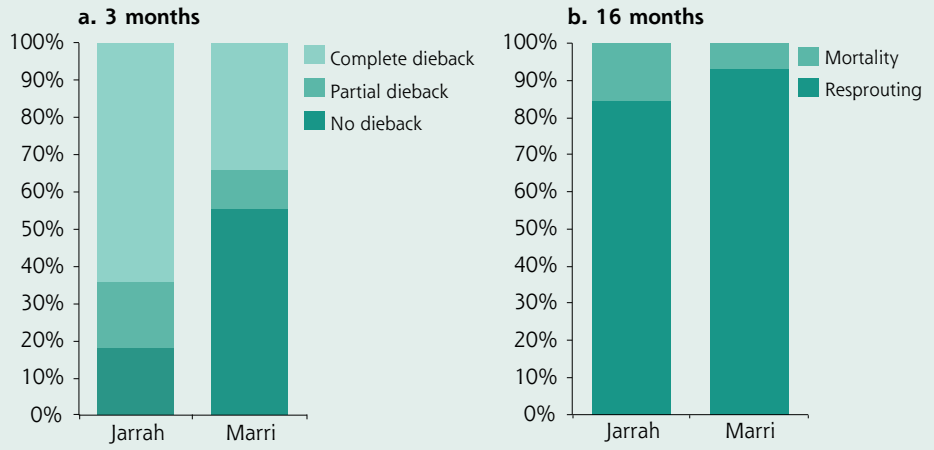

FIGURE 2 The probability of Marri and Jarrah trees experiencing: (a) complete crown dieback, partial crown dieback, no dieback after 3 months; (b) overall tree mortality and resprouting (of trees that experienced dieback) after 16 months following drought in the Northern Jarrah Forest, Western Australia

Conclusions and recommendations

These short-term differential responses to drought may lead to compositional shifts with increases in frequency of drought events in the future. If marri is able to maintain functioning crowns, produce flowers, attract pollinators and set viable seed more quickly than jarrah, it has the potential to drive longer term compositional changes.

Further research will offer critical information on longer-term health trajectories, canopy seed bank dynamics, natural recruitment, the drought-fire interactions that are likely to occur in this system, and the implications of shifting forest composition on faunal species that are reliant on these canopy species.

Our results have important implications for forest dynamics under predicted climatic conditions since the duration and severity of drought is expected to increase in Mediterranean and semi-arid regions across the globe (e.g. southwestern Australia, the southwestern United States including California, and the Mediterranean Basin). ■

More information

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1 The Nature Conservancy, Georgia Chapter, Chattahoochee Fall Line Conservation Office, Fort Benning, GA 31905, USA.

Excerpt from: Ruthrof, K.X., Matusick, G., and Hardy, G. (2015) Early differential responses of co-dominant canopy species to drought-induced forest dieback in Mediterranean southwestern Australia. *Forests* 6:2082–2091.

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